(12) UK Patent Application (19) GB (11) 2 288 359 (13) A

(43) Date of A Publication 18.10.1995

(21) Application No 9407034.9

(22) Date of Filing 08.04.1994

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(51) INT CL$^6$
B29C 41/04 41/22

(52) UK CL (Edition N )
B5A AT6P A1R314C1C A1R314C1X A1R314C2X
A1R420

(56) Documents Cited
GB 0336940 A US 5328349 A US 4634360 A

(58) Field of Search
UK CL (Edition M ) B5A AT6P AT8P
INT CL$^5$ B29C 41/04 41/06 41/22
Online databases:WPI

# (54) Rotational moulding of multicoloured articles

(57) Rotationally moulded plastics articles are generally moulded in a single colour or intermingled colours. Two or more coloured articles such as hollow cylindrical bollard or marker posts with a band of different coloured material may be made using a cylindrical two part mould (4, 6) into which moulding material is placed and then melted and distributed around the inside of a mould. While the mould is still hot, it is split into two parts (4, 6) and a further section (27) is inserted together with a charge of further differently coloured moulding material. The entire assembled composite mould (4, 27, 6) is then subjected to further, heating and rotation to form the bi-coloured article which is then removed from the mould in customary fashion.

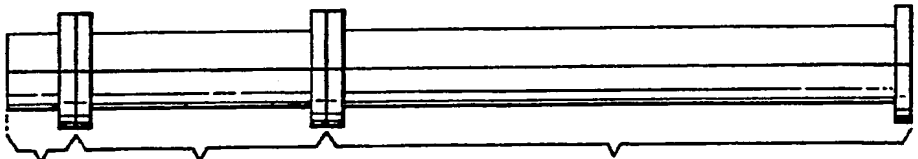


FIG.6

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At least one drawing originally filed was informal and the print reproduced here is taken from a later filed formal copy.

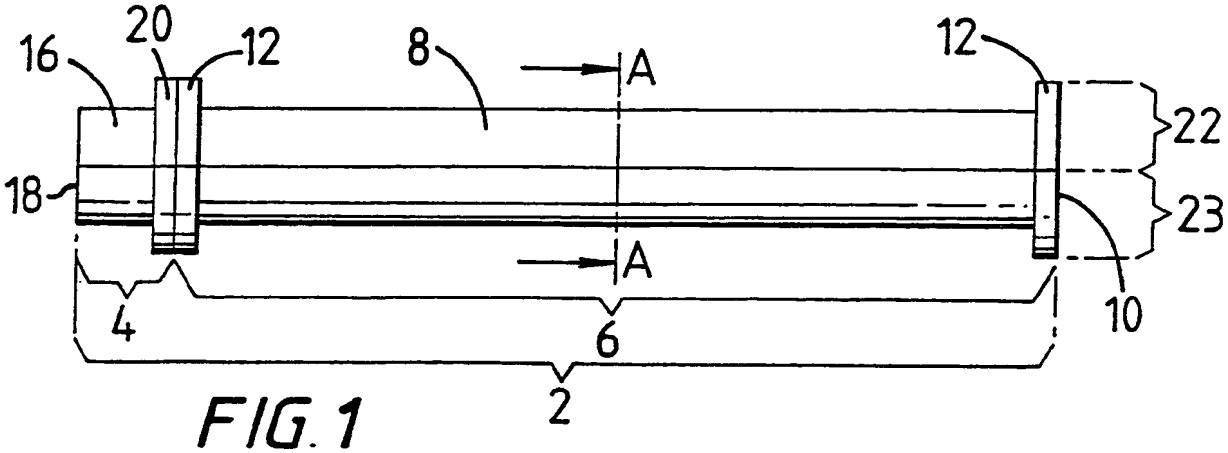


FIG. 1

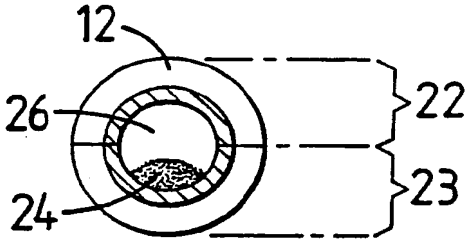


FIG. 2

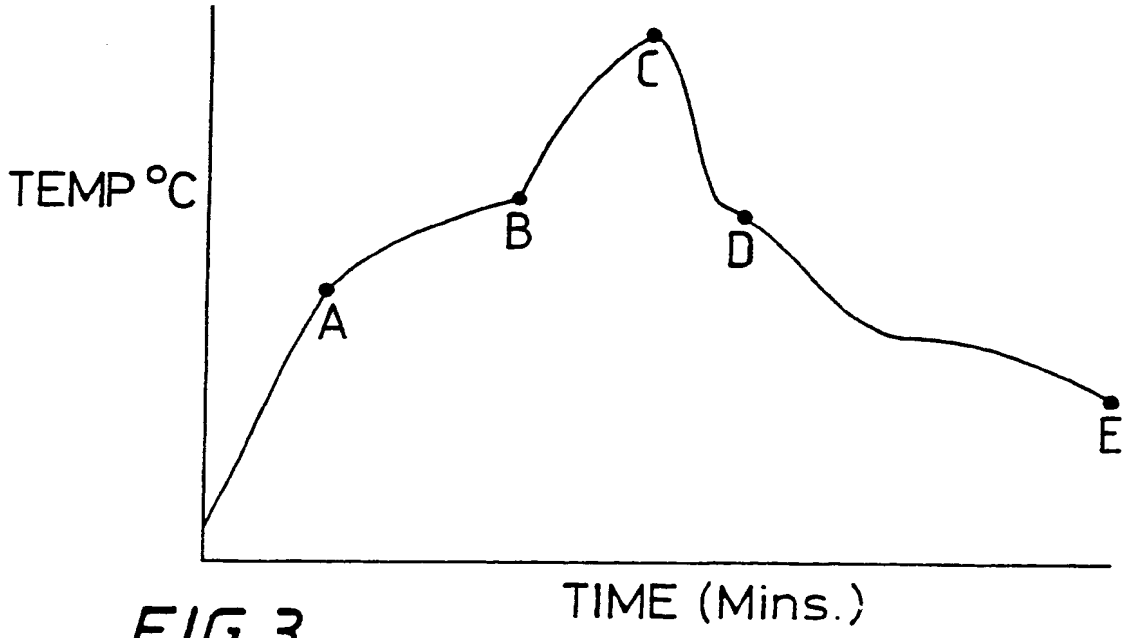


FIG. 3

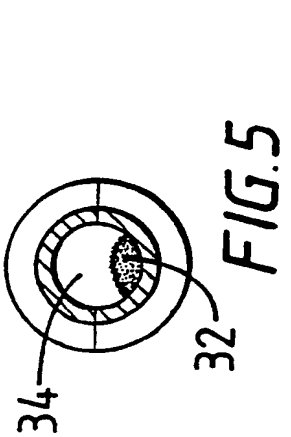


FIG.5

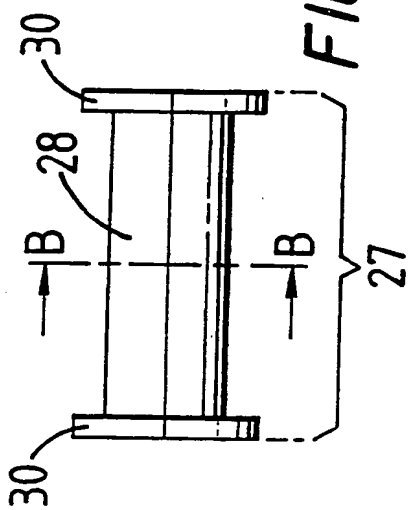


FIG.4

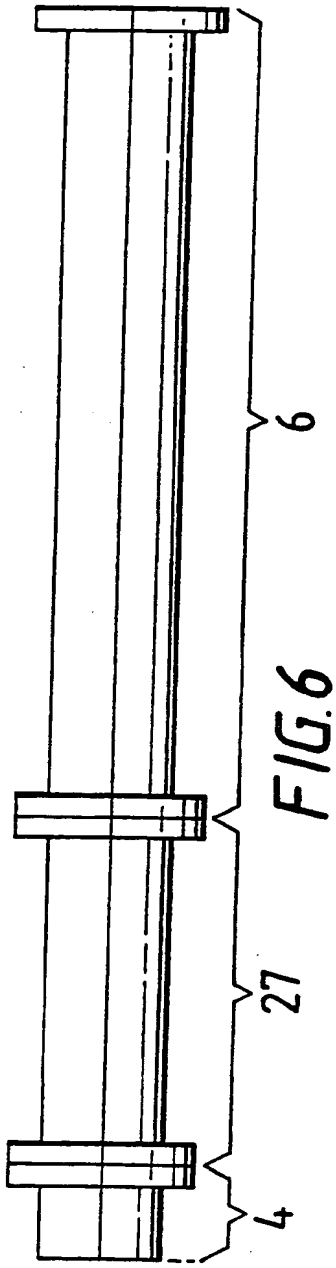


FIG.6

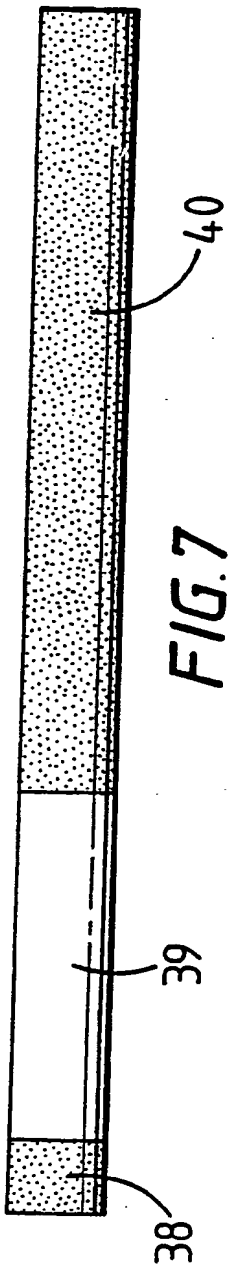


FIG.7

# ROTATIONAL MOULDING

This invention relates to rotational moulding and more particularly to a method of manufacturing a rotationally moulded article.

Rotational moulding is a known method for producing hollow plastics articles, allowing quite complex stress-free articles to be manufactured relatively simply and economically. A general description of the process is to be found in "Rotational Moulding of Plastics", Edited by R J Crawford, Research Studies Press 1992.

In general terms, the principal known method involves the introduction of a predetermined charge of cold, dry plastics powder into a cold hollow metal mould. After closure, the mould is rotated about its horizontal and vertical axes in a heated oven. The plastics powder inside the mould begins to melt and, (because of the slow biaxial rotation of the mould) coat all the inside surfaces of the mould. When all the powder has melted, the mould is transferred to a cooling bay where biaxial rotation of the mould is continued until the plastics coating has solidified. The mould can then be opened and

the product removed.

This method will be hereinafter referred to as a cycle of rotamoulding.

Various rotational moulding machines, ovens and cooling environments are known in the art. The known moulds are composed of a variety of metals for example sheet steel, cast aluminium, copper or electroplated nickel and can be of any desired shape, and do not necessarily have to be circular in section. Conveniently the mould is often divided through its horizontal axis into two halves which facilitates introduction of the powder into the mould before processing and the removal of the finished product when processing is completed. These halves are secured during processing, usually with quick releasing/locking clamps of known types.

Suitable materials for rotational moulding include all thermoplastics and some thermosetting plastics which can be finely ground, for example, low, medium and high density polyethylenes, linear or cross-linked polyethylenes, polyvinyl chloride, ethylene vinyl acetate and ethylene butyl acetate polymers, and polycarbonate resins.

Accordingly a wide variety of shapes and designs of plastics articles can be rotamoulded. However, up until the present invention only articles of a single colour or of intermingled colours could be manufactured in a single cycle. Rotamoulding of those articles have defined sections of different coloured plastics with clean break lines between each section has been very labour intensive, uneconomical and inconvenient. For such

articles it is necessary to process each differently coloured section separately because if differently pigmented powders are introduced into the same mould in the defined sections, clearly the rotation of the mould during the process would intermingle the differently pigmented powders so that the article produced would not have defined sections of colours as desired. Thin lines of colour between sections of a rotationally moulded article can be produced using certain complex techniques, e.g. as described in U S Patent Specification No.4610620, but the system there described is not usable for larger areas of different colour.

Consequently, up until the present invention the production by rotamoulding of an article having at least two defined sections of different colours has required a complete cycle of rotamoulding per section, followed by the securing of each separate sectional moulding together (by bolts, adhesives and the like) to produce the desired finished article. The manufacture is clearly very costly and inefficient; and the finished article has inherent weaknesses at the joints of the separate sections.

The present invention overcomes the inefficiencies of rotamoulding multi-coloured articles having clean break lines between each section of colour, by providing a method of rotamoulding which enables the manufacture of a unitary multi-coloured article, having clean break lines between each section of colour, in one cycle of rotamoulding.

According to the present invention there is provided a method of manufacturing a rotationally moulded article which comprises the steps of assembling together a rotary

casting mould from at least two sections, introducing into the rotary casting mould a quantity of moulding material, rotating the mould while heating its surface to distribute fused moulding material over the internal surface thereof, disassembling the mould and reassembling the mould with at least one further inserted mould section to provide a second closed mould of size larger than the first closed mould, introducing into the second closed mould a second charge of moulding material different from the first charge, rotating the mould while heating to deposit the second charge at least on the walls of the additional mould section, while heating the walls to fuse the second charge thereon and to fuse the second charge to the first charge, cooling the mould and removing the integral moulded article from the mould.

Preferably, the mould is disassembled at the point at which all the moulding material is stuck to the mould surface and is still viscous so that the sections of mould can be easily separated, but the material is processed sufficiently so that it will not significantly intermingle with the unprocessed material in the inserted section of the mould.

It is preferable that if more than one inserted mould section is introduced on reassembling the mould, then they are not located adjacent to one another, unless both are to be coated during the second rotamoulding stage with the same material.

If it is desired that inserts are located adjacent to one another which are to be coated with different moulding materials, then one insert must be introduced at a time so that steps of the method are repeated before

the final cooling of the mould.

Preferably the moulding material used is a finely powdered thermoplastics or thermosetting plastics material.

Preferably the moulding materials used for the initial and subsequent changes all reach complete fusion at approximately the same time so that the initial charge of material is not over-processed and the subsequent charges of material are not under-processed.

This may be achieved by a variety of methods. The moulding materials chosen for the initial and subsequent charges may be chosen according to their properties such that the materials chosen for the second and subsequent charges have either increasingly lower melting points or increasingly high melt-flow indices or increasingly smaller particle size, or else the quantities of moulding material for the initial and subsequent charges may be increasingly reduced.

The method according to the present invention may be applied to the manufacture of a very wide variety of articles conventionally made by rotamoulding such as large plastics casings, waste or litter bins and various articles of road furniture, which may be made in two or more colours (or with transparent or translucent sections) by using the new method. This will now be described by way of example with reference to the manufacture of a simple tubular article which is shown in the accompanying drawings wherein:

Figure 1 shows a side elevation of an assembled two

section casting mould for a hollow cylindrical post;

Figure 2 shows a vertical sectional view through the casting mould along line A-A of Figure 1;

Figure 3 shows a typical temperature profile of the air inside a mould during the stages of melting of a plastics powder and the formation of a coating on the inside surface of a mould in a rotamoulding process;

Figure 4 shows a side elevation of a mould section to be inserted;

Figure 5 shows a vertical sectional view through the mould section along line B-B of Figure 4, and

Figure 6 shows a side elevation of the reassembled casting mould containing the inserted section of Figure 4.

Figure 7 shows a side elevation of the finished item formed in the casting mould of Figure 6.

With reference to Figure 1, a metal casting mould 2 consists of a cap 4 and a main body 6. The main body comprises a hollow cylindrical section 8 which is closed at one end 10. Located at either end are circular flanges 12 to which are attached arms (not shown) for attachment of the mould to known rotating apparatus. The cap comprises a shorter hollow cylindrical section 16 which is closed at one end 18, and has a circular flange 20 at its open end. The cap and main body are axially

divided into two halves 22 and 23. The open ends of the cap and main body are secured together at their flanges by quick releasing/locking clamps of known type (not shown).

With reference to Figure 2, a quantity of a finely powdered moulding material 24 such as a thermoplastic powder, typically ground to 400-500 micron particle size, can be poured into hollow 26 of the cap and main body of the casting mould. Conveniently, the upper half 22 can be removed, to facilitate introduction of the moulding material into lower half 23 of the mould. After securing the two halves, the closed mould is attached to an apparatus for rotating the mould, and is rotated about its vertical and horizontal axis whilst being heated to the temperature required to melt the particular moulding material used. The apparatus and oven are of known type.

With reference to Figure 3, specific temperatures and times for processing depend on conditions such as material used, ambient air temperature and oven used. At the start of processing the mould and powder are cold and so the powder tumbles about freely. Up to point 'A' the temperature of the internal air rises until the powder and mould surface are sufficiently hot for the material to stick. At point A the first layers of plastic adhere to the inner surfaces of the mould. As the internal temperature continues to increase successive layers of powder adhere until point B where all the powder has adhered to the mould surface. It is at this point, where there is no free powder within the mould, but fusing the powder is incomplete that the mould is removed from the oven.

This is a critical temperature, since if this initial charge is underprocessed, then any free powder remaining in the mould will mix with the second charge of powder, but if the first charge is overprocessed, then in the second phase of heating, the initial charge will degrade. The critical temperature at point B will vary dependent of the particular material being processed, but it is used in carrying out the process of the present invention as an indicator of when to remove the mould and insert the further section(s).

Figure 4 shows a mould section 27, made up of a hollow cylindrical section 28 having circular flanges 30 at each end, the entire section being divided longitudinally into two halves.

Figure 5 shows a second charge of moulding material 32 of colour different to that of the initial charge and placed in the hollow interior 34 of the cold mould section.

The mould structure of Figure 6 is achieved by disassembling cap 4 from main body 6 and reassembling them together with interposition of the (cold) section 27, which is secured with suitable quick-release clamps to cap 4 and main body 6. The entire structure is then returned to the oven for the second phase of processing.

In this second phase, while being heated initially, the mould is rotated only about its main horizontal axis, so that the powder in section 27 stays in that section until it has fused and adhered to the internal walls of it, fusing to the earlier fused material at the ends of section 27. Once no powder is left, i.e. as the material in section 27 reaches point B in Figure 3, biaxial

rotation can recommence. The temperature then increases past point B, the molten material consolidates and any trapped air bubbles dissolve, to give a smooth coating over the entire mould interior. At temperature point C, the mould is removed from the oven before overprocessing can occur. With care, point C is reached for both charges at around the same time. If the internal temperature of the mould is being monitored, it is preferred to remove the mould from the oven just before point C is reached, thermal inertia then carrying the materials in the mould to the final point C.

Cooling, e.g by forced draught or immersion in water or water spraying, is then effected until the temperature of the charge passes through the melting point D and reaches point E at which it is sufficiently rigid to be removed from the mould. The final article is shown in Figure 7, consisting of a road bollard or marker post made of three integral sections of red, translucent and red plastics 38, 39 and 40 respectively.

The invention will be illustrated further by way of example of a specific rotamoulded article manufacture, using a mould as shown in the drawings. The dimensions of the cavity in cap 4 were depth 50mm, diameter 100mm, with the axial lengths of section 27 and body 6 being 150mm and 800mm respectively.

The mould of Figure 1 was assembled cold with 2.5kg of red linear polyethylene moulding powder, particle size about 500 microns and melt flow index 4-5, within. The mould was mounted on a conventional rotatable frame and the frame inserted into an oven.
The mould was rotated with an oven temperature of 300°C

at 10 rpm about its long axis and 1.5 to 2 rpm about an axis transverse thereto for 8 minutes. By the end of this, internal mould temperature was 110-130°C and point B on Figure 3 had been reached, with the powder on all the mould inner surfaces but not yet fully processed, though fused.

The mould was then removed from the oven, cap 4 removed and section 27 (containing 600g non-pigmented linear polyethylene moulding powder, particle size 400 microns, melt flow index 10) inserted. Cap 4 was refitted and the mould as in Figure 6 reinserted into the frame and the frame put back in the oven. Rotation of the mould only about its long axis and with that axis horizontal, so the unpigmented powder did not spread along the mould, was then carried out at 10 rpm for 10 to 12 minutes. Because of the lower quantity, smaller particle size and higher melt flow index (which means it was less viscous when molten), at the end of this period both charges had reached point C on Figure 3, and were fully fused. The internal mould temperature was around 190-200°C.

The mould was then removed from the oven, subjected to forced air cooling for 15 minutes and then disassembled to release an integrally moulded bollard or marker post as shown in Figure 7. The three sections were fused together with clean lines between them but without material weakness at the junctions between the sections.

CLAIMS

1. A method of manufacturing a rotationally moulded article which comprises the steps of assembling together a rotary casting mould from at least two sections, introducing into the rotary casting mould a quantity of moulding material, rotating the mould while heating its surface to distribute fused moulding material over the internal surface thereof, disassembling the mould and reassembling the mould with at least one further inserted mould section to provide a second closed mould of size larger than the first closed mould, introducing into the second closed mould a second charge of moulding material different from the first charge, rotating the mould while heating to deposit the second charge at least on the walls of the additional mould section, while heating the walls to fuse the second charge thereon and to fuse the second charge to the first charge, cooling the mould and removing the integral moulded article from the mould.

2. A method according to claim 1 wherein the amounts and types of the moulding materials and the times of heating are chosen such that both charges fully fuse at substantially the same time.

3 A method according to claim 1 or 2 wherein the first and second charges of moulding material are of the same general type but of different colours.

4. A method according to any one of claims 1 to 3 wherein the two charges are of finely divided thermoplastics material.

5. A method of rotamoulding a two- or more coloured

article substantially as hereinbefore described with reference to the accompanying drawings.

6. A rotationally moulded article made by the method of any one of claims 1 to 5.

**Patents Act 1977**
**Examiner's report to the Comptroller under Section 17**
**(The Search report)**

Application number
GB 9407034.9

**Relevant Technical Fields**

(i) UK Cl (Ed.M) B5A (AT6P, AT8P)

(ii) Int Cl (Ed.5) B29C 41/04, 41/06, 41/22

Search Examiner
MR M SIDDIQUE

Date of completion of Search
28 SEPTEMBER 1994

**Databases** (see below)
(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

(ii) ONLINE DATABASES: WPI

Documents considered relevant following a search in respect of Claims :-
1-6

**Categories of documents**

**X:** Document indicating lack of novelty or of inventive step.

**Y:** Document indicating lack of inventive step if combined with one or more other documents of the same category.

**A:** Document indicating technological background and/or state of the art.

**P:** Document published on or after the declared priority date but before the filing date of the present application.

**E:** Patent document published on or after, but with priority date earlier than, the filing date of the present application.

**&:** Member of the same patent family; corresponding document.

| Category | Identity of document and relevant passages | | Relevant to claim(s) |
|---|---|---|---|
| A | GB 336940 | (AMPHLETT) page 2 lines 65-71; page 3 lines 20-23, 75-82) separable mould sections | 1 |
| A | US 5328349 | (MINKE) Figures 1-4 etc | 1 |
| A | US 4634360 | (GRAY) see the drawing | 1 |


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